

Poultry Litter as a Fuel to Heat Broiler Houses

Thomas A. Costello, P.E.

Biological and Agricultural
Engineering Department



Outline of Presentation

- Need for Alternative Litter Use
- Feasibility of Litter as a Fuel
- On-Going Litter Combustion Demo

Outline of Presentation

- Need for Alternative Litter Use
- Feasibility of Litter as a Fuel
- On-Going Litter Combustion Demo

Alternative Poultry Litter Utilization

- Water Quality Concerns
 - Long-term Land Application ... High P
 - High Soil Test P ... High P in Runoff
 - Runoff from Fields Affects Stream and Lake
- Alternatives
 - Exported Product (ex., compost, fertilizer)
 - Manure to Energy

Manure to Energy

In all processes, non-volatile nutrients
and heavy metals are conserved.

– Wet vs. Dry Processes

$(\text{Dry Litter} + \text{Water}) - \text{Energy} = \text{Liquid Effluent}$

$(\text{Dry Litter}) - \text{Energy} = \text{Dry Ash} + \text{Exhaust Gases}$

– Combustion

- Central Plant or On-Farm
- 1-Stage, 2-Stage or Gasification
- Yields: Process-Heat, Electricity
and/or Producer-Gas

Advantages of On-Farm Litter Combustion

- No Transport (Costs, Bio-security)
- Space Heat Benefits (Less Propane)
- Ash (and P) can be Moved out of Watershed



Outline of Presentation

- Need for Alternative Litter Use
- Feasibility of Litter as a Fuel
- On-Going Litter Combustion Demo

Fuel Properties of Litter vs. Wood

Fuel	Energy Content (btu/lb)	MC (%, db)	Ash (%, db)	C (%, db)	N (%, db)
wood	8600	6.3%	0.5%	48.1%	0.3%
litter	6000	12.3%	33.1%	33.1%	5.0%

Space Heating Requirements

40 x 400 ft broiler house

Curtain-sided, NW Arkansas

- Propane for Space Heating: 5000 gal/year
- Annual Heat Demand: 450 million btu/yr
- Average Load (winter): 92,000 btu/h
- Peak Load (0 °F outside): 600,000 btu/h

Litter Required for Space-Heating

Offsets 80% of Load at 60% Efficiency

- Requires 50 tons litter per year
- 500 lb/day (average winter day)
- 1000 lb/(8-hours) (over night, peak)

For 40 x 400 ft curtain sided broiler house in NW Ark.

Economics of Litter as a Fuel to Offset Propane Costs

Interest Rate (APR)	----- Propane Cost (\$/gallon) -----			
	\$0.90	\$1.00	\$1.10	\$1.20
	Present Value of 7-Year Fuel Savings			
2.0%	\$23,066	\$25,629	\$28,192	\$30,755
5.0%	\$20,623	\$22,914	\$25,205	\$27,497
10.0%	\$17,351	\$19,279	\$21,207	\$23,135

For 40 ft x 400 ft house, NW Arkansas, 80% of space heating supplied by litter. Does not include loss of benefits of litter as fertilizer or any cost/benefits of ash.

Litter-Fired Space Heating Infrastructure

- Furnace
- Heated-Air Delivery and Mixing
- Fuel Feeding
- Fuel (Litter) Storage
- Ash Storage and Marketing

Furnace Options

- Two-Stage Combustion Furnace
 - Lynndale Mfg., Harrison, AR
 - To be tested by Univ. of Arkansas
- Litter Gasifier (producer-gas)
 - Community Power Corp., Littleton, CO
 - Demonstration next week in Colorado
- Others ...

Heated Air Delivery and Mixing

- Central Source of Heated Air
- Thermostat to Control Furnace
- Need to Duct Heated Air into House
- Need to Distribute Heated Air thru House

Heated Air Distribution

- Flow Divider
- Axial Fans
- Inflatable Plastic Tubes



Fuel Feeding

- 500 lb/day (average in winter)
- 1000 lb over-night (peak)
- Need 1 to 2 cu. yards hopper capacity



Fuel Storage

- Need 50 tons litter per year (each house)
- If cleanout once per year then will need storage capacity for 50 tons per house
- Stacking Shed vs. Wind-Row with Tarp



Building a Windrow



Simple, Covered Pile

20 ft bottom width, 6 ft depth, 3 ft top width
need windrow 50 ft long for 50 tons stored



Ash Production

Fuel	Apparent Ash Production (lb/ton, wb)	Apparent Ash Production (%, db)	Ash Content of Fuel (%, db)
wood	12	0.56%	0.53%
litter	430	19.1%	33.1%

Some ash will exit as particulates with exhaust gases.

Ash Storage and Marketing

From 50 tons of Litter Combusted

- Accumulate 10 tons of Ash
 - Volume of about 6 cu. yd.
- Non-volatile Litter Constituents Remain
 - Phosphorus and Potassium
 - Heavy Metals: Arsenic, Zinc, Copper
- Market Outside Sensitive Watershed
 - Economic Value (or Cost?)

Outline of Presentation

- Need for Alternative Litter Use
- Feasibility of Litter as a Fuel
- On-Going Litter Combustion Demo

Demonstration Project

- Funded by EPA through ASWCC, with matching funds from ADEQ
- Two Test Phases: Lab and On-Farm
- Furnace Mfg by Lynndale in Harrison, Ark.
- Monitor:
 - litter incineration rate
 - furnace efficiency and heat delivered
 - quality/quantity of ash and emissions
 - ‘hassle factor’ for operation on-farm

Expected Result of Project

- Demos of Furnace Operations
- Document Benefits
- Document Costs
 - from environmental perspective
 - from economic perspective
- Help Farmers make Decision to Adopt Technology

Lynndale Furnace during Installation at UA Engineering Research Center



Expected Benefits

- Alternative to Land Application of Litter
 - shunt up to 75,000 tons of litter per year from sensitive watersheds
- Reduced Space Heating Costs (Propane)
 - litter from one house should provide enough fuel for the majority of the space-heating
- Possible Market Value of Ash

Expected Costs

- Loss of Fertilizer Value of Litter
- Capital Cost of Furnace, Fuel/Ash Handling, Heated Air Distribution
- Labor and Management to Operate
- Possible Air Pollution (to be checked)

Technical Monitoring

- Fuel and Combustion-Air Mass Flow Rates
- Heated Air Temperature and Airflow Rate
- Stack Temperature
- Ash Production and Composition
 - nutrients (P, K) and heavy metals (As, Zn)
- Composition of Emissions
 - carbon monoxide
 - NO_x

For More Information Contact:

Tom Costello

Associate Professor

Biological & Agricultural Engineering Dept.

University of Arkansas

203 ENGR Hall

Fayetteville, AR 72701

tac@uark.edu

479-575-2847

It's got to go somewhere...

